

Research on the Influence of Slack Resource on the Peer Effect of Enterprise R&D Investment: The Moderating Effect of Environmental Uncertainty

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Abstract

Today's market is highly competitive and the external environment is unstable, enterprises need to carry out technological innovation to improve their competitiveness. However, the technological innovation activities of enterprises are related to the slack resource and the R&D investment behavior of the peer enterprises. Therefore, this paper investigates the influence of slack resource on the peer effect of enterprise R&D investment and the moderating effect of environmental uncertainty on the relationship between slack resource and the peer effect of enterprise R&D investment based on the A-share listed companies in China from 2011 to 2020. The results of this research show that both absorbed slack resource and unabsorbed slack resource negatively affect the peer effect of enterprise R&D investment, and environmental uncertainty plays a negative moderating effect between absorbed slack resource and the peer effect of enterprise R&D investment. The above research findings provide strong evidence that Chinese enterprises can efficiently explore and transform internal slack resource and fully invest them in R&D activities to improve the level of enterprise technological innovation and take measures to stabilize the external market environment.

Keywords

Slack Resource; The Peer Effect of Enterprise R&D Investment; Environmental Uncertainty; Moderating Effect.

1. Introduction

In today's highly competitive market, the innovative development of enterprises has become more and more important, China is also paying more and more attention to the development of innovative technology in enterprises. In the face of a complex international environment, China pointed out that strengthening innovation is the only way to grasp and lead the times. It further proposed accelerating the implementation of the innovation-driven development strategy, mastering core technologies and breaking through technical difficulties. It adheres to creative transformation and innovative development, pursues high-quality development, strengthens independent innovation capability, and optimizes the market environment for innovation. Enhance the effectiveness of scientific and technological investment, safeguard the country's economic security, so as to achieve a high level of scientific and technological self-reliance and self-improvement, and build a modernized and powerful country.

In order to maintain their position in the fierce market competition and improve their competitiveness, enterprises have to carry out the innovation activities of R&D investment, however, the investment activities of enterprises need sufficient resources for investment, coupled with the outstanding characteristics of enterprise R&D activities with information asymmetry, spillover and high risk. When external resources are not sufficiently available, the supporting role of slack resource within the enterprise becomes particularly important. Cyert & March(1963) pointed out that slack resource is stored in the enterprise's internal, which is a

buffer pool of resources that can cope with changes in the external environment and policy adjustments ^[1]. Slack resource may enhance a firm's ability to adapt to environmental changes and buffer the adverse effects of environmental uncertainty (Sharfman, 1988) ^[2]. Slack resource may partially assist firms in adjusting their policies and strategies based on internal and external pressures, or even initiate change (Bourgeois, 1981) ^[3]. Categorizing slack resource and then studying them separately, it can be found that absorbed slack resource has a positive impact on exploitative innovation and unabsorbed slack resource has a positive impact on exploratory innovation. If enterprises can fully explore and utilize the two kinds of slack resource, the pressure of competition for resources between the two kinds of innovations can be weakened, which can help to maintain the coordination and balance between absorbed and unabsorbed slack resource (Li, 2009) ^[4]. Making full use of the slack resource within the enterprise to carry out innovative activities can provide strong support for the enterprise's innovative activities, and greatly promote the innovative development of the enterprise. At present, many enterprises in China have the problem of overcapacity, so how to make full use of the slack resource within the enterprise and put them into the enterprise's innovative R & D investment has great research significance, and at the same time, the enterprise's R & D investment behavior has a peer effect, the enterprise in the face of decision-making reference information is insufficient or uncertain, it will be through the imitation of other enterprises in order to reduce the cost of information searching, and thus improve their own decision-making efficiency (Shen & Su, 2012) ^[5]. Sevilir (2017) pointed out that when an enterprise carries out innovation activities, the peer enterprises driven by it will also participate in innovation activities, observe and learn from each other how to make innovation decisions, thus forming a wave of innovation ^[6]. That is to say, when one enterprise starts to carry out technological research and development or introduction, followed by other enterprises, this constant sharing and mutual competition will continuously promote the overall level of the enterprise, thus stimulating a positive innovation spillover effect (Bloom, 2013) ^[7]. According to Miles et al. (1978), most firms will make and implement decisions based on the external environment ^[8]. Higher environmental uncertainty can aggravate the information asymmetry problem, increase the business risk of enterprises, and seriously increase the burden of the cost of debt capital of enterprises (Lin, 2015) ^[9].

For this reason, this study tries to divide slack resource into two categories and examine the role of absorbed slack resource and unabsorbed slack resource on the R&D investment peer effect, in order to explore whether slack resource within the company can weaken the peer effect of R&D investment. Whether it negatively affects the R&D investment peer effect of the enterprise. At the same time, we investigate whether environmental uncertainty has a moderating effect between slack resource and R&D investment peer effect.

The innovations of this paper are mainly reflected in the following: first, domestic and foreign studies mainly focus on the impact of slack resource on R&D investment of enterprises, and there are few studies on the impact of slack resource on the peer effect of R&D investment of enterprises. This paper explores the impact of slack resource on the peer effect of enterprise R&D investment, which helps us to have a more in-depth understanding of the peer effect of enterprise R&D investment, and is conducive to strengthening the mining and utilization of slack resource. Second, environmental uncertainty is difficult for enterprises to avoid and has a certain impact on their R&D investment decisions, and this paper incorporates environmental uncertainty into the analytical framework and expands related research.

There are still some deficiencies in this paper, which can be improved as follows: First, improve the measurement method of enterprise R&D investment. It is not comprehensive enough to focus only on R&D investment, but also on the direction and structure of R&D investment. Second, further subdivide the slack resource. For example, the impact of selling expenses, administrative expenses and financial expenses on the peer effect of enterprise R&D

investment should be studied separately. Third, further explore the internal factors of enterprises. The environmental uncertainty introduced in this paper considers the external environment, however, there are also many factors within the enterprise that affect the peer effect of R&D investment.

2. Theoretical Analysis and Research Hypothesis

2.1. The Effect of Slack Resource on the Peer Effect of Enterprise R&D Investment

Slack resource can alleviate the conflict within the enterprise, the enterprise has a certain degree of slack resource, can through the rational allocation of slack resource to meet the desire of each internal functional department, in order to reduce the enterprise within the process of competition with each other may produce conflict. At the same time, it also enhances the independence, flexibility and consistency of goals between the various functional departments within the enterprise (Moch & Pondy,1977)^[10]. If the more slack resource in the enterprise, the easier it is to carry out innovative research and development activities, the less pressure there is on management to perform, and the more the enterprise tends to take the initiative to carry out technological innovation (Zhen,2013)^[11]. When the external environment is unstable, the slack resource of an enterprise can keep key business processes and core technologies unaffected, or mitigate the impact of environmental uncertainty (Singh,1986)^[12]. With the support of slack resource, firms are able to maintain the stability of their core technologies, thus providing a solid foundation for their new R&D activities. Nelson & Winter(1982) found that slack resource promotes the development of high-risk projects, and sometimes they can create unanticipated good benefits for the firm ^[13]. The existence of slack resource can offset the losses caused by failures and protect firms from the risk and uncertainty of failure, thus favoring enterprise innovative activities (Laffranchini & Braun,2014)^[14]. When other firms in the same cluster conduct R&D activities, there are more constraints for the firm because the availability of external resources is generally limited. If firms have more slack resource to utilize, they can fully invest them in innovative R&D, and thus can better conduct independent R&D, and the peer effect of enterprise R&D investment may be weakened.

Some scholars believe that after categorizing slack resource, different types of slack resource have different characteristics, so the relationship between different types of slack resource and the peer effect of enterprise R&D investment may be somewhat different. There are differences in the innovation activities of enterprises affected by absorbed slack resource and unabsorbed slack resource (Li,2009)^[4]. In this paper, slack resource is categorized into absorbed slack resource and unabsorbed slack resource. Resources that have been inenterprised into the production process and are difficult to reconfigure are referred to as absorbed slack resource, while underutilized flow resources that can be configured in multiple directions are referred to as unabsorbed slack resource. Greve(2003) found that absorbed slack resource positively affects R&D investment in a selected group of firms in Japan's shipbuilding industry, while unabsorbed slack resource and potential slack resource do not have a significant impact on R&D investment ^[15]. Unabsorbed slack resource positively affects firm innovation and is stronger than absorbed slack resource(Liu et al.,2014) ^[16]. Li & Gao(2014) found that unabsorbed slack resource is significantly and positively related to self-innovation activities ^[17]. Chen(2018) found that unabsorbed slack resource is more significantly positively correlated with R&D investment, and the gap between absorbed and unabsorbed slack resource will negatively affect R&D investment ^[18]. George(2005) pointed out that firms with more absorbed slack resource will have stronger confidence that managers will be more proactive in formulating and adopting new strategies to continuously improve their R&D capabilities ^[19]. Based on the theory of organizational inertia, Yi(2018)proposed that both unabsorbed slack

resource and absorbed slack resource have a positive effect on product innovation, but the effect of unabsorbed slack resource is stronger than absorbed slack resource^[20]. Therefore, this paper categorizes slack resource into absorbed slack resource and unabsorbed slack resource, and investigates their effects on the peer effect of enterprise R&D investment separately.

Therefore, based on the above analysis, this paper proposes the following hypothesis:

H1a: Absorbed slack resource has a negative effect on enterprise R&D investment peer effect. The more absorbed slack resource an enterprise has, the weaker the enterprise R&D investment peer effect is.

H1b: Unabsorbed slack resource has a negative effect on enterprise R&D investment peer effect. The more unabsorbed slack resource an enterprise has, the weaker the enterprise R&D investment peer effect is.

2.2. The Moderating Role of Environmental Uncertainty

When enterprises face the fierce market environment and information asymmetry, most of them will pay more attention to the external environment, and the peer effect of enterprise R&D investment will be affected by the environmental uncertainty. From the R&D investment decision of the peer enterprises, we can find out the enterprise's judgment on the future development prospect of R&D innovation, so as to provide a basis and reference for other enterprises to make decisions on R&D investment. However, as the unpredictability of the external environment increases, the risk faced by enterprises in R&D investment also increases. Therefore, enterprises are more inclined to learn from the R&D investment behavior of other enterprises in order to minimize the risk and uncertainty, and thus the peer effect of enterprise R&D investment will be enhanced. For enterprise technological innovation, environmental uncertainty is an important influence factor, i.e., the higher the environmental uncertainty, the more adversely affected the enterprise R&D will be (Yuan,2015)^[21]. The higher the uncertainty of the external environment, the higher the possibility of failure in the process of enterprise innovation. Firms will reduce their R&D investment and shift to other activities such as equity investment, thus avoiding unnecessary economic losses (Xing,2022)^[22]. When the uncertainty of the environment increases, the operational and financial risks faced by the firms may also increase, which may lead to a decline in the performance of the firms. By squeezing cash flow and weakening endogenous sources of financing, management will reduce the firm's investment in technological innovation in order to avoid risks (Yang,2018)^[23]. Environmental uncertainty enhances enterprise resilience and stimulates learning, encouraging firms to continuously optimize their performance in the field of technological innovation to gain new competitive advantages (Liu,2019)^[24].

Therefore, when the external environmental uncertainty is stronger, the company in order to avoid the risk of R&D activities as much as possible. Then it will weaken the intensity of independent R&D and enhance the learning of the R&D investment behavior of other peer enterprises, thus enhancing the peer effect of enterprise R&D investment. In this paper, environmental uncertainty is used as a moderating variable, and since slack resource is divided into absorbed slack resource and unabsorbed slack resource to be studied separately, this paper next tries to investigate whether environmental uncertainty has a moderating effect between absorbed slack resource and the peer effect of enterprise R&D investment, as well as the moderating effect between unabsorbed slack resource and the peer effect of enterprise R&D investment, respectively.

Therefore, based on the above analysis, this paper proposes the following hypothesis:

H2a: Environmental uncertainty plays a negative moderating role between absorbed slack resource and enterprise R&D investment peer effect, i.e., the stronger the environmental uncertainty, the weaker the negative role of absorbed slack resource on enterprise R&D investment peer effect.

H2b: Environmental uncertainty plays a negative moderating role between unabsorbed slack resource and the peer effect of enterprise R&D investment, i.e., the stronger the environmental uncertainty, the weaker the contribution of unabsorbed slack resource to the peer effect of enterprise R&D investment.

3. Research Design and Data Sample

3.1. Variable Design

3.1.1. Dependent Variable

The dependent variable in this paper is the peer effect of enterprise R&D investment, which is measured by referring to the treatment of Song et al. (2023)^[25] with the following formula:

$$RD_Peer_{i,t} = \left| RD_{i,t} - \frac{(\sum_1^n RD_{i,t-1} - RD_{i,t-1})}{n-1} \right|$$

Where $RD_Peer_{i,t}$ is the peer effect of firm i 's R&D investment in year t . $RD_{i,t}$ is firm i 's R&D investment in year t , and also the ratio of firm i 's total R&D investment in year t to its operating revenue. $RD_{i,t-1}$ is firm i 's R&D investment in year $t-1$, and also the ratio of firm i 's total R&D investment in year $t-1$ to its operating revenue. n is the number of firms in firm i 's industry in year $t-1$. If the absolute value of this difference is larger, it indicates that the gap between the R&D investment of the enterprise and peer enterprises is more obvious, and the peer effect of enterprise R&D investment is smaller.

3.1.2. Independent Variable

The independent variable in this paper is slack resource, based on Singh's (1986) classification of slack resource into absorbed and unabsorbed slack resource^[12]. Drawing on the measurement method of Xie & Wei (2016)^[26], this paper measures unabsorbed slack resource by subtracting the firm's quick ratio from the industry average of this indicator. In addition, the formula for the measurement of absorbed slack resource is as follows:

$$AbSlack = \frac{\text{Management Costs} + \text{Sales Costs} + \text{Finance Costs}}{\text{Revenues}} - \text{Industry Average for This Indicator}$$

3.1.3. Moderating Variable

The moderating variable in this paper is environmental uncertainty, drawing on the measurements of Shen & Yu (2012)^[27] to regress the operating income and yearly variables using the least squares method, model (1) is established as follows:

$$Sale = \varphi_0 + \varphi_1 Year + \varepsilon \quad (1)$$

Where $Sale$ represents the firm's sales revenue and $Year$ represents the year variable. $Year$ takes the value of 12 if sales revenue is timed to 2021, and 1 if it is timed to 2010. The residual ε represents abnormal sales revenue, whose standard deviation divided by the average sales revenue is the industry-unadjusted environmental uncertainty. The median of the unadjusted environmental uncertainty of the same industry in the same year is the environmental uncertainty of the industry. In this paper, we refer to the method of Ghosh & Olsen (2009)^[28] and define the ratio of the unindustry-adjusted environmental uncertainty to the industry environmental uncertainty as the adjusted environmental uncertainty.

3.1.4. Control Variable

Referring to previous scholars' studies, some control variables are selected in this paper as shown in Table 1.

Table 1. Definitions and Descriptions of Relevant Variables

Variable Type	Variable Name	Variable Symbol	Variable Measurement
Dependent Variable	Average R&D Investment of Peer Companies	RD_Peer	R&D investment of the enterprise minus the average value of R&D investment of enterprises other than the enterprise itself in the industry in which the enterprise is located in the previous period, and then take the absolute value.
Independent Variable	Absorbed Slack Resource	AbSlack	(Management Costs+Sales Costs+Finance Costs)/ Revenues-Industry Average for This Indicator
	Unabsorbed Slack Resource	UnAbSlack	Quick Ratio- Industry Average for This Indicator
Moderating Variable	Environmental Uncertainty	Eu	Calculated by Borrowing from Shen et al. to Obtain
Control Variable	Enterprise Performance	Roa	Earnings on Total Assets
	Asset-liability Ratio	Lev	Total Liabilities to Total Assets
	Enterprise Size	Size	Natural Logarithm of Total Assets
	Enterprise Age	Age	Natural Logarithm of the Number of Years Since the Establishment of the Enterprise
	Enterprise Growth	Grow	Growth Rate of Main Business Income
	Cash Flow from Operations	CF	Net Cash Flow from Operating Activities to Total Assets Ratio
	Equity Concentration	Top1	Shareholding Ratio of the Company's Largest Shareholder
	Nature of Property	Property	Dummy Variable
	Area	Area	Dummy Variable
	Industry	Industry	Dummy Variable
	Year	Year	Dummy Variable

3.2. Model Construction

In order to test the influence of control variables on the peer effect of enterprise R&D investment, and initially test the main factors affecting the peer effect of enterprise R&D investment, this paper establishes the model (2). Where β_0 is the constant term and $\varepsilon_{i,t}$ is the residual term.

$$RD_Peer_{i,t+1} = \beta_0 + \beta_1 Roa_{i,t} + \beta_2 Lev_{i,t} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Grow_{i,t} + \beta_6 CF_{i,t} + \beta_7 Top1_{i,t} + \beta_8 Property_{i,t} + \beta_9 Area_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (2)$$

In order to test the effect of slack resource on the peer effect of enterprise R&D investment, this paper establishes model (3). Where β_0 is the constant term and $\varepsilon_{i,t}$ is the residual term.

$$RD_Peer_{i,t+1} = \beta_0 + \beta_1 AbSlack_{i,t} + \beta_2 UnAbSlack_{i,t} + \beta_3 Roa_{i,t} + \beta_4 Lev_{i,t} + \beta_5 Size_{i,t} + \beta_6 Age_{i,t} + \beta_7 Grow_{i,t} + \beta_8 CF_{i,t} + \beta_9 Top1_{i,t} + \beta_{10} Property_{i,t} + \beta_{11} Area_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (3)$$

In order to test the moderating role of environmental uncertainty on the relationship between slack resource and the peer effect of enterprise R&D investment, this paper establishes model (4). Where β_0 is the constant term and $\varepsilon_{i,t}$ is the residual term.

$$RD_Peer_{i,t+1} = \beta_0 + \beta_1 AbSlack_{i,t} + \beta_2 UnAbSlack_{i,t} + \beta_3 Eu_{i,t} * AbSlack_{i,t} + \beta_4 Eu_{i,t} * UnAbSlack_{i,t} + \beta_5 Eu_{i,t} + \beta_6 Roa_{i,t} + \beta_7 Lev_{i,t} + \beta_8 Size_{i,t} + \beta_9 Age_{i,t} + \beta_{10} Grow_{i,t} + \beta_{11} CF_{i,t} + \beta_{12} Top1_{i,t} + \beta_{13} Property_{i,t} + \beta_{14} Area_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \tag{4}$$

3.3. Sample Selection and Data Sources

In this paper, the data of China's A-share listed companies in the period of 2011-2020 are selected from CSMAR database and annual reports of listed companies. The data were processed and analyzed by Stata17.0 software with the following treatments: (1) Excluding financial listed companies. (2) Excluding listed companies with ST, PT, *ST, G*ST during this period. (3) Samples with outliers and incomplete data were excluded. (4) Shrinking all continuous variables at the 1% and 99% quantile, resulting in 6,822 valid samples.

4. Empirical Results and Analysis

4.1. Descriptive Statistical Analysis

The results of descriptive statistical analysis of the main variables are shown in Table 2. The mean value of the peer effect of enterprise R&D investment is 0.0177 and the minimum value is 0.0002, which indicates that some enterprises have a large peer effect of enterprise R&D investment. The maximum values of absorbed slack resource and unabsorbed slack resource are 0.3326 and 5.0883, respectively, and the mean values are -0.0011 and -0.0385, respectively, indicating that there is more slack resource in some enterprises, which, if fully invested in R&D activities, can improve the capability of independent innovation. The average value of environmental uncertainty is 1.1481 and the maximum value is 5.6909, indicating that some enterprises face strong environmental uncertainty.

Table 2. Descriptive Statistics of Main Variables

Variable	Sample Size	Minimum Value	Median	Maximum Value	Average Value	Standard Deviation
RD_Peer	6500	0.0002	0.0122	0.1118	0.0177	0.0192
AbSlack	6822	-0.1924	-0.0123	0.3326	-0.0011	0.0867
UnAbSlack	6822	-1.8011	-0.2124	5.0883	-0.0385	1.0443
Eu	6822	0.1277	0.8906	5.6909	1.1481	0.9552
Roa	6822	-0.1402	0.0306	0.1954	0.0372	0.0508
Lev	6822	0.0913	0.4886	0.8830	0.4793	0.1851
Size	6822	20.1000	22.6000	26.5000	22.6966	1.3045
Age	6822	2.0794	2.9444	3.4340	2.9002	0.2705
Grow	6822	-0.7316	0.0765	0.6675	0.0619	0.2100
CF	6822	-0.1290	0.0474	0.2320	0.0510	0.0639
Top1	6822	0.0944	0.3294	0.7402	0.3498	0.1446
Property	6822	0.0000	1.0000	1.0000	0.6051	0.4889
Area	6822	1.0000	1.0000	3.0000	1.5415	0.7499

4.2. Correlation Analysis

The results of the Pearson correlation analysis carried out in this paper are shown in Table 3, since the enterprise R&D investment peer effect is a reverse indicator, both AbSlack and UnAbSlack are significantly and positively correlated with the enterprise R&D investment peer effect at the 1% level, which indicates that the more slack resource there is, the smaller the enterprise R&D investment peer effect is. In addition, the correlation coefficients between the variables are less than 0.8, indicating that there is no multicollinearity problem between the variables.

Table 3. Correlation Coefficient Table

Variable	RD_Peer	AbSlack	UnAbSlack	Eu	Roa	Lev	Size	Age	Grow	CF	Top1	Property	Area
RD_Peer	1.0000												
AbSlack	0.1418***	1.0000											
UnAbSlack	0.0752***	0.0427***	1.0000										
Eu	-0.0029	0.0342***	0.0146	1.0000									
Roa	0.0021	-0.1133***	0.2671***	-0.0504***	1.0000								
Lev	-0.1534***	-0.0498***	-0.5749***	0.0495***	-0.4025***	1.0000							
Size	-0.1518***	-0.1411***	-0.1940***	-0.0062	0.0277**	0.4316***	1.0000						
Age	-0.0200*	-0.0308**	-0.0501***	0.0051	-0.0156	0.0065	0.1433***	1.0000					
Grow	-0.0235*	-0.1458***	-0.0298**	0.1229***	0.3020***	0.0146	0.0666***	-0.0616***	1.0000				
CF	-0.0408***	-0.0665***	0.1135***	-0.0640***	0.4643***	-0.2154***	0.0892***	0.0243**	0.0792***	1.0000			
Top1	-0.1348***	-0.1161***	-0.0090	0.0699***	0.0692***	0.1413***	0.2840***	-0.1733***	-0.0034	0.1014***	1.0000		
Property	-0.0876***	-0.1507***	-0.1164***	-0.0180	-0.1447***	0.2047***	0.2254***	0.0457***	-0.0427***	-0.1051***	0.2929***	1.0000	
Area	-0.0303**	0.0672**	-0.0264**	0.0496***	-0.1058***	0.0719***	-0.0203*	-0.0232*	-0.0396***	-0.0823***	0.0358***	0.1483***	1.0000

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

4.3. Regression Results Analysis

4.3.1. The Effect of Slack Resource on the Peer Effect of Enterprise R&D Investment

Table 4. Regression Results on the Effect of Slack on R&D Investment Peer Effect

Variable	(1)	(2)	(3)	(4)
AbSlack		0.0257***		0.0257***
		(7.20)		(7.25)
UnAbSlack			0.0016***	0.0016***
			(4.11)	(4.26)
Roa	0.0061	0.0093	0.0039	0.0071
	(1.00)	(1.53)	(0.64)	(1.17)
Lev	-0.0037**	-0.0033**	0.0031*	0.0035*
	(-2.36)	(-2.15)	(1.66)	(1.86)
Size	-0.0006***	-0.0004*	-0.0006***	-0.0004*
	(-2.74)	(-1.70)	(-2.88)	(-1.83)
Age	-0.0025**	-0.0020**	-0.0024**	-0.0019*
	(-2.41)	(-2.00)	(-2.32)	(-1.91)
Grow	-0.0008	0.0003	-0.0007	0.0005
	(-0.74)	(0.29)	(-0.62)	(0.40)
CF	-0.0078**	-0.0067*	-0.0067*	-0.0057
	(-2.07)	(-1.81)	(-1.78)	(-1.52)
Top1	-0.0046***	-0.0034**	-0.0049***	-0.0037**
	(-2.89)	(-2.13)	(-3.08)	(-2.32)
Property	-0.0002	0.0006	-0.0001	0.0007
	(-0.39)	(1.17)	(-0.11)	(1.46)
Area	0.0007***	0.0005*	0.0007**	0.0005*
	(2.62)	(1.93)	(2.42)	(1.74)
_cons	0.0404***	0.0334***	0.0377***	0.0307***
	(7.32)	(6.05)	(6.79)	(5.52)
Industry	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	6059	6059	6059	6059
r ²	0.3331	0.3452	0.3374	0.3495
r ² _a	0.3260	0.3381	0.3302	0.3424
F	5.8547	9.0933	6.2706	9.1791

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively; t-values based on robust standard error adjustments are in parentheses.

In order to study the influence of slack resource on the peer effect of enterprise R&D investment, the regression analysis results of this paper are shown in Table 4. Column (1) shows the regression of control variables and dependent variables, and it can be seen that Lev, Size, Age, CF and Top1 have a significant positive impact on the peer effect of enterprise R&D investment. Column (2) shows the regression with AbSlack on top of control and dependent variables, which shows that the coefficient of AbSlack is significantly positive at the 1% level, verifying hypothesis H1a. Column (3) shows the regression with UnAbSlack on top of control and dependent variables, which shows that the coefficient of UnAbSlack is positive and significant at the 1% level. The results show that the coefficient of UnAbSlack is positive and significant at the 1% level, testing hypothesis H1b. Column (4) shows a regression with AbSlack and UnAbSlack on top of the control and dependent variables to investigate the effect of the two types of slack resource on the peer effect of enterprise R&D investment, and the results show that the coefficients of both AbSlack and UnAbSlack are positive and significant at the 1% level.

4.3.2. The Moderating Role of Environmental Uncertainty

In order to study the moderating effect of environmental uncertainty, this paper conducted a regression analysis of the model constructed in the previous section, and the results are shown in Table 5. Column (1) presents the regression results with the addition of moderating and control variables, and it can be seen that the coefficient of Eu is not significant, so environmental uncertainty has no significant effect on the peer effect of enterprise R&D investment. Column (2) shows the regression results after adding the moderating variables on the basis of AbSlack and control variables, and column (3) shows the regression results after adding the moderating variables on the basis of UnAbSlack and control variables, and it can be seen that the regression coefficient of Eu for both columns is 0.0002, and the T-value is 0.86, which is not significant, which indicates that environmental uncertainty has no direct effect on the peer effect of enterprise R&D investment. This indicates that environmental uncertainty has no direct effect on the peer effect of enterprise R&D investment. Column (4) shows the regression results after adding Eu on the basis of AbSlack, UnAbSlack and control variables, the regression coefficient of Eu is 0.0001, the T-value is 0.5, which is not significant, indicating that the environmental uncertainty does not have a direct impact on the peer effect of enterprises R&D investment. Column (5) shows the addition of the cross-multiplier term AbSlackEu_c on top of AbSlack, Eu and control variables, which shows that the R^2 increases from 0.3453 to 0.3472, and the adjusted R^2 increases from 0.3381 to 0.3399, and the regression coefficient of the cross-multiplier term is -0.0089, with a T-value of -2.70, which is significant at the 1% level, indicating that there is a moderating effect. There is a moderating effect, and the analysis combined with the main effect reveals that environmental uncertainty attenuates the influence of absorbed slack resource on the peer effect of enterprise R&D investment, which verifies hypothesis H2a. Column (6) presents the addition of UnAbSlackEu_c on top of UnAbSlack, Eu, and control variables, and the T-value of the cross-multiplication term is -0.94, which is not significant, and rejects hypothesis H2b. Column (7) presents the cross-multiplier term on top of AbSlack, UnAbSlack, Eu and control variables, and from the results, it can be seen that AbSlackEu_c is significantly negatively correlated with RD_Peer at 1% level, and analyzing it together with the main effect, it can be found that environmental uncertainty plays a negative moderating role in the peer effect of absorbed slack resource and enterprise R&D investment. However, the cross-multiplier term UnAbSlackEu_c is not significant, indicating that environmental uncertainty does not have a moderating effect on the relationship between unabsorbed slack resource and the peer effect of enterprise R&D investment.

Table 5. Regression Results on the Moderating Effect of Environmental Uncertainty

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
AbSlack		0.0256***		0.0256***	0.0264***		0.0265***
		(7.17)		(7.23)	(7.40)		(7.48)
UnAbSlack			0.0016***	0.0016***		0.0016***	0.0017***
			(4.06)	(4.23)		(4.12)	(4.42)
AbSlackEu_c					-0.0089***		-0.0091***
					(-2.70)		(-2.70)
UnAbSlackEu_c						-0.0003	-0.0002
						(-0.94)	(-0.76)
Eu	0.0003	0.0002	0.0002	0.0001	0.0003	0.0002	0.0002
	(1.22)	(0.86)	(0.86)	(0.50)	(1.17)	(0.93)	(0.86)
Roa	0.0064	0.0095	0.0041	0.0072	0.0088	0.0040	0.0063
	(1.04)	(1.56)	(0.67)	(1.19)	(1.44)	(0.66)	(1.05)
Lev	-0.0037**	-0.0034**	0.0030	0.0034*	-0.0035**	0.0030	0.0034*
	(-2.38)	(-2.17)	(1.60)	(1.82)	(-2.26)	(1.60)	(1.84)
Size	-0.0006***	-0.0004*	-0.0006***	-0.0004*	-0.0003	-0.0006***	-0.0004*
	(-2.71)	(-1.68)	(-2.86)	(-1.82)	(-1.54)	(-2.88)	(-1.70)
Age	-0.0025**	-0.0021**	-0.0024**	-0.0019*	-0.0021**	-0.0023**	-0.0019*
	(-2.45)	(-2.03)	(-2.35)	(-1.93)	(-2.05)	(-2.31)	(-1.90)
Grow	-0.0010	0.0002	-0.0009	0.0004	-0.0004	-0.0009	-0.0002
	(-0.91)	(0.14)	(-0.74)	(0.31)	(-0.31)	(-0.79)	(-0.19)
CF	-0.0075**	-0.0065*	-0.0065*	-0.0055	-0.0063*	-0.0065*	-0.0052
	(-1.99)	(-1.75)	(-1.72)	(-1.48)	(-1.69)	(-1.71)	(-1.40)
Top1	-0.0048***	-0.0035**	-0.0051***	-0.0038**	-0.0034**	-0.0051***	-0.0037**
	(-3.00)	(-2.22)	(-3.16)	(-2.37)	(-2.15)	(-3.17)	(-2.31)
Property	-0.0002	0.0006	-0.0000	0.0007	0.0007	-0.0000	0.0008*
	(-0.32)	(1.22)	(-0.06)	(1.48)	(1.37)	(-0.03)	(1.68)
Area	0.0007**	0.0005*	0.0007**	0.0005*	0.0005*	0.0007**	0.0005*
	(2.55)	(1.89)	(2.38)	(1.71)	(1.89)	(2.37)	(1.71)
_cons	0.0401***	0.0333***	0.0375***	0.0306***	0.0326***	0.0375***	0.0298***
	(7.27)	(6.02)	(6.76)	(5.51)	(5.93)	(6.75)	(5.39)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	6059	6059	6059	6059	6059	6059	6059
r2	0.3333	0.3453	0.3375	0.3496	0.3472	0.3378	0.3518
r2_a	0.3261	0.3381	0.3302	0.3423	0.3399	0.3303	0.3443
F	5.3552	8.2941	5.7307	8.4143	8.3590	5.3117	7.9411

Note: ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively; t-values based on robust standard error adjustments are in parentheses.

In order to show the moderating effect of environmental uncertainty more intuitively, this paper plots Figure 1. The slope gradually becomes smaller with increasing environmental uncertainty, so environmental uncertainty attenuates the negative influence of absorbed slack on the peer effect of enterprise R&D investment, verifying H2a.

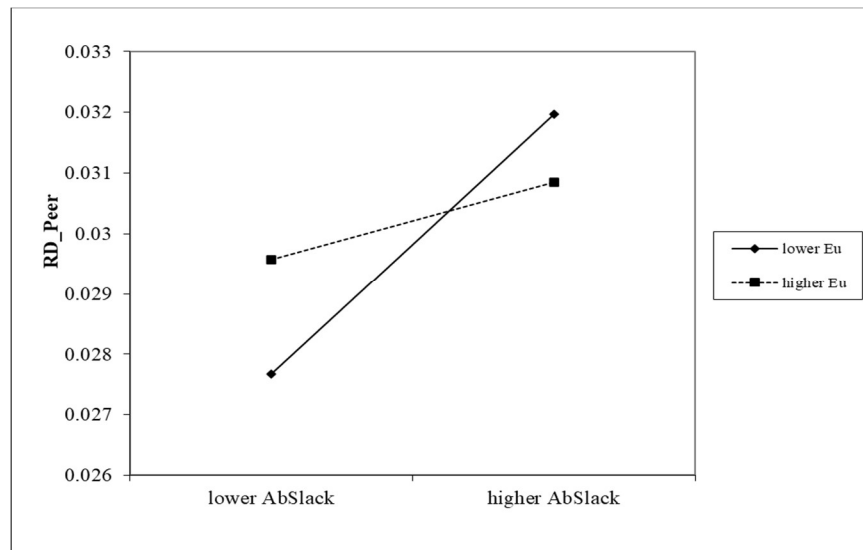


Figure 1. Moderating Role of Environmental Uncertainty

4.4. Robustness Testing

In order to ensure the robustness of the results, this paper replaces the mean value of the R&D investment of other enterprises in the industry except for the enterprise itself with the median value in the R&D investment peer effect measurement method, and then conducts regression analysis again, which is consistent with the previous conclusion. In addition, the industry mean value of the indicator in the slack resource measurement method is replaced with the median value and regressed separately, which is also consistent with the previous conclusion, indicating that the hypotheses of this paper are robust.

5. Conclusion and Implications

This paper selects Chinese A-share listed companies from 2011 to 2020 as a sample, and through empirical analysis of enterprise R&D investment peer effect, slack resource, environmental uncertainty and control variables, it studies the impact of slack resource on enterprise R&D investment peer effect, and the moderating effect of environmental uncertainty on the relationship between slack resource and enterprise R&D investment peer effect. The following conclusions are drawn: (1) Absorbed slack resource negatively affects the peer effect of enterprise R&D investment. (2) Unabsorbed slack resource negatively affects the R&D investment peer effect. (3) Environmental uncertainty negatively moderates the relationship between absorbed slack resource and R&D investment peer effect. (4) Environmental uncertainty has no moderating effect between unabsorbed slack resource and R&D investment peer effect.

Based on the above conclusions, this paper puts forward the following suggestions: (1) China is building an innovative country, and should improve the enthusiasm and success rate of R&D and innovation activities, and enhance the independent innovation ability of enterprises. Build a platform for enterprise R&D information exchange to help some enterprises make better decisions on R&D investment, and promote innovation "increase quantity and improve quality". (2) Slack resource inevitably exist within enterprises, but slack resource are not necessarily "redundant" or "inefficient". If they can be fully tapped and actively invested in R&D activities, the technological innovation level of the enterprise can be enhanced. The weaker the environmental uncertainty, the better the absorbed slack resource can attenuate the homogeneous effect of enterprise R&D investment, and the scientific arrangement and rational utilization of slack resource can better promote the development of enterprises. (3) This paper finds that the weaker the environmental uncertainty, the more obvious the negative effect of

absorbed slack resource on the peer effect of enterprise R&D investment. The government should take measures to create a more stable market environment, so as to enhance the negative effect of absorbed slack resource on the peer effect of enterprises R&D investment, to better utilize the positive role of slack resource, to promote the development and improve the core competitiveness of Chinese enterprises.

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